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UNION CARBIDE NUCLEAR COMPANY
DIVISION OF UNION CARBIDE CORPORATION

MEMORANDUM

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DATE: October 22, 1958

TO: H.F. Henry

FROM: P.L. Durrill, M.P. Aronchick, and R.H. Wick

SUBJECT: A Background Radiation Survey of the Area Immediately Surrounding the Oak Ridge Gaseous Diffusion Plant

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SUMMARY

During the period from October 10 to October 16, 1958, a background radiation survey of the area immediately surrounding the Oak Ridge Gaseous Diffusion Plant (ORGDP) was made. Although the area within the ORGDP fence has been monitored for radioactivity regularly, this was the first attempt to make an extensive survey of the area surrounding the plant.

Alpha and beta-gamma survey meter readings were taken, and air, water, soil, and vegetation samples were collected in the area extending outward approximately one mile from the fence surrounding the plant.

The results of the survey were compared with accepted tolerance levels, and with those results obtained from similar surveys made at Shippingport, Pennsylvania, and Paducah, Kentucky, prior to start-up of the nuclear installations at these sites and at Knolls Atomic Power Laboratory, Schenectady, New York, during a period of normal operation.

For the fourteen air samples which were analyzed, the maximum long-lived alpha activity was less than 10% of the accepted tolerance level, and the maximum long-lived beta activity was less than 0.3% of the accepted tolerance level. "Accepted tolerance level", as used throughout this report, refers to the maximum permissible radiation level for a particular type of radiation emanating from an unknown source.

Of the five water samples analyzed, only one exhibited alpha and beta activities above the accepted tolerance levels. However, the gross alpha and beta activity for this sample, which was collected from a sewer stream very near the plant fence, was less than 10% of the maximum permissible gross activity due to uranium in water.

Analyses of four soil and four vegetation samples for alpha activity showed the alpha activity in soil and vegetation to be in the same range reported in the Paducah and Shippingport surveys.

The range of vegetation beta activity determined by analyses of forty-nine vegetation samples was about the same as that reported in the Knolls and Shippingport surveys.

For over 80% of the forty-five soil samples analyzed, the soil beta activity exceeded the maximum soil beta activities found at Knolls, Paducah, and Shippingport. The average soil beta activity was twice as great as the maximum value reported in the Paducah survey, four times as great as the maximum value reported in the Shippingport survey, and ten times as great as the maximum value reported in the Knolls survey.

The maximum gross activity reading observed with the beta-gamma survey meter was 0.08 milliroentgens per hour, which is about 1.0% of the maximum permissible whole-body dose rate.

Fallout from a large number of nuclear weapons tests which took place during the week in which the survey was made probably contributed appreciably to the total beta activity in the area.

There was no relationship between activity and geographical location with respect to the plant. Soil activity could not be related to the type of soil sampled. Deciduous foilage was generally found to be more active than non-deciduous foilage.

INTRODUCTION

The natural background radiation at the surface of the earth is due to cosmic rays from outer space and to radioactive material found in the ground, in the atmosphere, and in all forms of life. Within the past twenty years, man has begun to make large-scale use of naturally-occurring and artifically-produced radioactive materials. As a result, the background radiation levels in many locations have risen above the natural background levels. The exact long-term effects which these increases in background radiation levels will have on various forms of life are not known.

Installations which deal with large quantities of radioactive material in any form must take extensive measures to prevent contamination of the plant site and surrounding areas. Such contamination might be due to the release of radioactive material in waste streams, to errors in operation, or to equipment failure. Detection and measurement of the extent of contamination in the vicinity of a nuclear installation can be accomplished by periodic radiation surveys or by continuous monitoring techniques. The determination of radiation levels, which are the magnitudes of the activities due to the various types of radioactivity, is an integral part of the safety program at a plant which deals with radioactive material.

The purpose of this investigation was to determine the radiation levels existing in the area immediately surrounding the Oak Ridge Gaseous Diffusion Plant. Radiation levels are constantly being checked within the plant, and some monitoring is done beyond the fence. However, no extensive survey of radiation levels outside the plant area had been conducted prior to this investigation, and no preliminary background radiation survey was made in this area prior to start-up of the plant.

The area which was surveyed extended outward approximately one mile from the fence surrounding ORGDP. Alpha and beta-gamma survey meter readings were taken, and air, water, soil, and vegetation samples were collected at locations which are shown on Figure 1. The samples were analyzed in such a manner as to determine the individual contributions made by alpha, beta, and gamma radiation to the total activity. Water samples were analyzed for alpha, beta, and gamma activity; air samples

for alpha and beta activity; and all soil and vegetation samples for beta and gamma activity. In addition, alpha activities of four soil and four vegetation samples were determined.

RESULTS

The background radiation levels determined in this survey are summarized in Table I. Only ranges and average values are given; the complete survey data are tabulated in Table III of Appendix D. The significant results are as follows:

1) There was no geographical relationship between background radiation level and location with respect to ORGDP for any type of radiation.

2) No gamma activity could be detected in the water, soil, and vegetation samples. (Air samples were not analyzed for gamma activity.)

3) The ratio of specific alpha to specific beta activity for air, water, soil, and vegetation varied with location in a non-systematic manner. The average value of the ratio of specific alpha activity to specific beta activity was approximately 0.1 for air, soil, and vegetation and 0.5 for water.

4) Alpha activity of the air samples covered a wide range of values. The fourteen samples collected can be divided into two distinct groups, one consisting of those samples collected during the first three days of the survey and the other, of those samples collected during the last three days. Samples collected during the last three days were from two to fifteen times as active as the samples in the other group.

The air samples contained some short-lived alpha emitters which resulted in high alpha counting rates when the samples were counted soon after they were collected. Samples were as much as one-hundred times more active forty-five minutes after collection than they were twenty hours later.

Air sample beta activities differed from one another by as much as a factor of five.

5) There was no relationship between the type of soil and its specific activity.

6) For samples taken at the same location, the specific beta activity of poison sumac foilage was generally higher than for red cedar. This was the only relationship evident between the type of vegetation and its specific activity.

TABLE I

SUMMARY OF BACKGROUND RADIATION LEVELS(1)

		Range	Average
Beta-gamma survey meter readings		0 - 0.08 milliroentgens per hour	0.04 milliroentgens per hour
Alpha survey meter readings		0 - 300 counts per minute	60 counts per minute
Air samples	Alpha	0.00195 - 0.0284 counts per minute per cubic foot(2)	0.00915 counts per minute per cubic foot
		0.878×10^{-9} - 12.8×10^{-9} microcuries per cubic foot	4.12×10^{-9} microcuries per cubic foot
	Beta	0.0307 - 0.157 counts per minute per cubic foot	0.099 counts per minute per cubic foot
		1.38×10^{-8} - 7.06×10^{-8} microcuries per cubic foot	4.46×10^{-8} microcuries per cubic foot
Water Samples	Alpha	0.04 - 0.96 counts per minute per milliliter	0.288 counts per minute per milliliter
		1.8×10^{-8} - 43.2×10^{-8} microcuries per milliliter	13.0×10^{-8} microcuries per milliliter
	Beta	6.75×10^{-8} - 75.2×10^{-8} microcuries per milliliter	21.3×10^{-8} microcuries per milliliter
Vegetation Samples	Alpha	12 - 30 counts per minute per gram	18.4 counts per minute per gram
		5.4×10^{-6} - 13.5×10^{-6} microcuries per gram	8.4×10^{-6} microcuries per gram
	Beta	65 - 275 counts per minute per gram	164 counts per minute per gram
		2.92×10^{-5} - 12.4×10^{-5} microcuries per gram	7.4×10^{-5} microcuries per gram
Soil Samples	Alpha	10 - 20 counts per minute per gram	15 counts per minute per gram
		4.5×10^{-6} - 9.0×10^{-6} microcuries per gram	6.8×10^{-6} microcuries per gram
	Beta	28 - 652 counts per minute per gram	159 counts per minute per gram
		1.26×10^{-5} - 29.3×10^{-5} microcuries per gram	7.0×10^{-5} microcuries per gram

NOTES: (1) No gamma activity was detectable in the water, vegetation, or soil samples. Air samples were not analyzed for gamma activity because the necessary equipment was not available.

(2) All alpha activities reported in this table are due primarily to long-lived emitters and represent counting rates determined by analysis of the samples twelve hours or more after they were collected. Short-lived alpha activities of air samples are included in Table III of Appendix D.

7) High beta activity in vegetation at a given location did not necessarily signify a high beta activity in the soil, and vice versa. However, at a given location, alpha activities for soil and vegetation appeared to increase or decrease concomitantly.

8) Of the five water samples collected, one was from a sewer stream located just outside the fence and not far from the K-1024 Building, which is at the center of the ORGDP processing area. The location at which this sample was taken is shown as Point 8 on Figure 1. This water sample was much more active than the rest.

9) The analyses of forty-nine vegetation samples and forty-five soil samples for beta activity and four soil and four vegetation samples for alpha activity showed that average alpha and beta activities were about the same for soil as for vegetation. The average specific beta activities of soil and vegetation were over three hundred times as great as the average for water, while the corresponding average specific alpha activities were over fifty times as great.

DISCUSSION OF RESULTS

The first part of this section consists of an analysis of the observations presented in the Results section. Background radiation levels determined in this survey are then compared with those reported in similar surveys at three other nuclear installations and with accepted tolerance levels. Finally, the accuracy of the results is discussed.

Analysis of Observations

The background radiation levels were independent of location in the area which was surveyed. This indicates either that the deposition of radioactive material from ORGDP and other sources is isotropic in the surveyed area and thus independent of wind direction and topography of the area or that ORGDP's contribution to the total background radiation level is small compared with the background due to natural radioactivity and fallout.

During the period in which this background radiation survey was made there was little rainfall, very little wind, and hardly any change in the weather whatsoever. For five of the seven days during which the survey was made, the prevailing wind direction was NE, which is normal for the ORGDP area. Average wind speed ranged from 2.2 to 5.3 miles per hour. Appendix C contains climatological data for the survey period. The results of this survey probably would not be reproducible during a period of markedly different weather conditions.

Weather conditions such as the amount of precipitation and wind direction are known to have considerable effect on background radiation levels, although the exact nature of this effect is not readily predictable. Brookhaven National Laboratory reported marked increases in ground level activity after rainfall, and decreases after snowfall and in generally colder weather (25). The former effect was attributed to the carrying down of radioactive dust particles by the rain, while the latter was explained as being due to inhibition of the emission of radioactive gases, principally radon, from the ground. Such effects are strictly local in nature and point to the importance of a thorough knowledge of local weather conditions, both past and present, in the analysis of background radiation data.

Another factor which might lead to difficulty in reproducing the results of this survey is the large number of nuclear weapons tests which took place during the week in which the survey was made. Identification of the nuclides responsible for the observed radioactivity would make it possible to predict the source of the radiation. The presence of large amounts of strontium-90, for example, would indicate that fallout of material released from nuclear weapons tests was making a significant contribution to the background radiation level. The presence, in their natural relative proportions, of elements known to be naturally occurring in the earth's outer crust in a given area would indicate that background was mainly due to natural radioactivity. In addition to aiding in the prediction of the source of the radioactivity, identification of the nuclides responsible for the activity would permit determination of the energies of the radiations and calculation of an actual dose rate for persons exposed to this background. Due to the relatively small amount of radioactive material which would be present in the samples to be analyzed, chemical identification might not be practical, in which case a mass spectrograph could be used. Identification of the nuclides responsible for the radiation levels found in this survey was not attempted.

The increase in alpha activity in the air during the last three days of the survey could conceivably have been due to an increase in the amount of uranium hexafluoride released to the atmosphere at ORGDP; however, there is evidence that no unusual situations occurred in the plant which might have caused such a release. It is also possible that the increase in alpha activity was due to increased fallout from weapons tests conducted during the survey period or to other unidentified natural phenomena. In any case, the maximum air sample activity was well below the accepted alpha tolerance level for air, as will be discussed in the next part of this section.

The high alpha counting rates observed for air samples which were counted shortly after being collected were probably due in part to radon-thoron emanation from the ground. It would be of particular interest to determine the identity of the nuclides responsible for the short-lived alpha activity in air. Aside from chemical or instrumental methods of identification, some idea as to the identity of these nuclides might possibly be obtained by making a rough calculation of the effective half-life of the dust particles collected from the air. This would involve counting the filter paper as soon as possible after removal from the air sampler and then at ten- to thirty-minute intervals until at least three points on the decay curve are determined.

It would be suspected that surface samples of different types of soil would give different specific activities due to the fact that rate of leaching depends upon the type of soil. Dependence of specific activity on type of soil was not evident. However, this should not be taken as evidence that all soils in the surveyed area leach in the same manner, since insufficient samples were collected, and since the method of classifying the samples was completely qualitative. Samples were classified either as red clay or as a second type which included all samples which had no resemblance to red clay.

It was not expected that the activity of poison sumac foilage would be greater than that of red cedar, for two reasons. First, cedar is an evergreen, while sumac is deciduous. Secondly, cedar has a more dense foilage surface exposed to the air than does sumac. The greater activity of sumac might be attributed to the fact that it absorbs more water from the ground than does cedar. However, this does not seem especially plausible, for little radioactive material is likely to pass down through the soil from the surface to a depth where the roots are located. The difference might be due to different amounts of potassium-40 in the two types of vegetation. Since an insufficient number and variety of samples were collected, more data are needed to lend statistical support to the finding of this survey that deciduous foilage exhibits higher activity than non-deciduous foilage.

Higher alpha and beta counting rates were found for both vegetation and soil than for water. Only surface samples of water were collected, and it is possible that samples taken at the bottom of a pond or stream would have been more active because of the settling out of water-insoluble radioactive material.

Comparison of Background Radiation Levels

In Table II the radiation levels determined in this background radiation survey are listed along with the levels determined in three similar surveys at other nuclear installations and the accepted tolerance levels. The term "accepted tolerance level" refers to the maximum permissible radiation level for a particular type of radiation emanating from an unknown source.

The Shippingport (15) and Paducah (26) surveys were made before the nuclear installations at these sites began operation, while the survey at Knolls Atomic Power Laboratory (2) was made during a period of normal operation.

Air alpha activities due to long-lived emitters were roughly the same as determined in the Paducah survey. The maximum long-lived alpha activity observed in the air was 10% of the accepted tolerance level. Air beta activities had a range almost identical to that determined in the Knolls survey. The maximum long-lived beta activity level in air was about 0.3% of the accepted tolerance level.

KT-369

TABLE II

COMPARISON OF BACKGROUND RADIATION LEVELS[1]

		Installation				
		ORGDP	KAPL (2)	Paducah (26)	Shippingport (15)	Accepted Tolerance Levels
Air Samples	Alpha	0.00195 - 0.0284 counts per minute per cubic foot		0.018 counts per minute per cubic foot		
		0.87×10^{-9} - 12.8×10^{-9} microcuries per cubic foot				14.2×10^{-8} microcuries per cubic foot (24)
	Beta	0.0307 - 0.157 counts per minute per cubic foot				
		1.38×10^{-8} - 7.06×10^{-8} microcuries per cubic foot	1.11×10^{-8} - 5.33×10^{-8} microcuries per cubic foot (3)			2.84×10^{-5} microcuries per cubic foot (24)
Water Samples	Alpha	0.04 - 0.96 counts per minute per cubic centimeter				
		1.8×10^{-8} - 43.2×10^{-8} microcuries per cubic centimeter				10^{-7} microcuries per cubic centimeter (24)
	Beta	0.15 - 1.67 counts per minute per cubic centimeter				
		6.75×10^{-8} - 75.2×10^{-8} microcuries per cubic centimeter	21×10^{-8} microcuries per cubic centimeter (4)		7×10^{-12} - 9×10^{-12} microcuries per cubic centimeter (16)	10^{-7} microcurie per cubic centimeter (24)
Vegetation Samples	Alpha	12 - 30 counts per minute per gram	Negligible (5)		7.0 ± 2.6 counts per minute per gram (17)	
		5.4×10^{-6} - 13.5×10^{-6} microcuries per gram				
	Beta	65 - 275 counts per minute per gram			52 - 351 counts per minute per gram (17)	
		2.92×10^{-5} - 12.4×10^{-5} microcuries per gram	9.2×10^{-5} - 28×10^{-5} microcuries per gram (5)			
Soil Samples	Alpha	10 - 20 counts per minute per gram	Negligible (6)	6 ± 1.1 counts per minute per gram	19.2 - 41.5 counts per minute per gram (18)	
		4.5×10^{-6} - 9.0×10^{-6} microcuries per gram				
	Beta	28 - 652 counts per minute per gram		76 ± 21 counts per minute per gram	34.5 - 42.5 counts per minute per gram (18)	
		1.26×10^{-5} - 29.3×10^{-5} microcuries per gram	3×10^{-6} - 8.7×10^{-6} microcuries per gram (6)			
Beta-gamma Survey Meter Readings		0.- 0.08 milliroentgens per hour				Maximum permissible whole-body dose = 7.5 milliroentgens per hour (7)

NOTE: (1) "KAPL" refers to Knolls Atomic Power Laboratory, Schenectady, New York.
"Paducah" refers to the Union Carbide Nuclear Company Plant at Paducah, Kentucky.
"Shippingport" refers to the Atomic Power Station at Shippingport, Pennsylvania.

The maximum alpha activity in vegetation was four times as great as the maximum reported at Shippingport, whereas the beta activity in vegetation was essentially the same as reported at Shippingport and one-half that reported at Knolls.

The maximum alpha activity in soil was about three times that found at Paducah and one-half the maximum found at Shippingport. The maximum soil beta activity was much greater than that found at Knolls, Paducah, and Shippingport. However, this maximum is rather misleading as it was due to a single sample which was more than twice as active as forty-two of the remaining forty-four samples. The average soil beta activity was twice as great as the maximum reported at Paducah; four times as great as the maximum at Shippingport, and almost ten times the maximum value reported at Knolls.

The highest water alpha activity was found in a water sample taken from a plant drain line wherein trace quantities of uranium may routinely be expected. The activity measured in this sample was four times the accepted tolerance level for unknown alpha emitters but far below the corresponding figure for uranium. The location at which this sample was collected is shown as Point 8 on Figure 1. The average water alpha activity was roughly equivalent to the accepted tolerance level. The average beta activity for the five water samples which were collected was identical to that reported in the Knolls survey but about ten thousand times as great as the activity reported at Shippingport. This average beta activity was twice the accepted tolerance level, whereas the maximum water beta activity was eight times the accepted tolerance level for an unknown beta emitter, but was only 0.0015% of the maximum permissible value of 5×10^{-2} microcuries per cubic centimeter for uranium decay products (Th^{234} and Pa^{234}) (19). Uranium daughter products are the only beta emitters of any significance which might be released at ORGDP. The maximum beta activity was due to the same sample responsible for the maximum alpha activity. The gross alpha and beta activity for this sample was less than 10% of the maximum permissible gross activity (2.1×10^{-5} microcuries per cubic centimeter) due to uranium in water (24). Uranium and uranium decay products are the only alpha emitters of importance which could possibly be released at ORGDP.

The maximum reading of 0.08 milliroentgens per hour observed with the beta-gamma survey meter is well below the maximum permissible whole-body dose rate of 7.5 milliroentgens per hour. An environmental background radiation survey carried out within the past two years (23) showed that background radiation in the United States ranged from 0.01 to 0.10 milliroentgens per hour. The background radiation level at Chattanooga, Tennessee, was 0.011 to 0.0123 milliroentgens per hour.

The differences between the background radiation levels determined in this survey and the values reported in the Paducah and Shippingport surveys can be attributed either to natural variation of background radiation levels with location, to fallout, to the actual discharge of radioactive material from nuclear installations in the vicinity, namely ORGDP and Oak Ridge National Laboratory (ORNL), or to any combination of these three factors.

The actual contributions which ORGDP and ORNL have made to the total background radiation levels could best be determined by comparing the results of this survey with the results of surveys made in the vicinity of ORGDP and ORNL either before or shortly after operation of the facilities at these sites was begun. No pre-operational background radiation surveys were made at ORGDP or at ORNL, but the possibility of the existence of reports concerning radiation surveys which were made within five years after start-up of the facilities should be investigated. A report concerning air monitoring at ORNL in 1945 (1) is known to have been issued but it had not been obtained at the time this report was prepared.

Accuracy of Results

1. Survey meter readings

   a. The Samson alpha meter specifications estimate a 10% uncertainty in the alpha survey meter readings. In operation the meter readings drifted considerably at low counting rates, and it is estimated that the average alpha meter readings are valid within 50%.

   b. The beta-gamma survey meter specifications estimate a 10% uncertainty. These readings were subject to considerably less drift than those observed with the alpha meter, and the average readings are considered accurate to within 20%.

2. Sample counting rates

   The samples were counted to an uncertainty of 5% with a limit of error of 10%. Errors in laboratory procedures are estimated at no more than 5% in any case. Therefore, the maximum error in the specific activities is about 15%.

3. Location of Sample Points

   All sample points are considered to be located accurately on the map of Figure 1 to within 100 feet. This uncertainty is due to the difficulty experienced in locating many points accessible only by previously unmapped roads.

SUMMARY OF RESULTS AND CONCLUSIONS

1) During the period in which this background radiation survey was made, the alpha and beta activities in the air in the area immediately surrounding ORGDP were well below accepted tolerance levels.

2) The activity of water in the area was far below the maximum permissible gross activity level for uranium in water. However, the alpha and beta activities of one water sample exceeded the accepted tolerance levels for an unknown source.

3) Soil and vegetation alpha activities were comparable to those reported in background radiation surveys made at Paducah and Shippingport prior to the beginning of operation of the nuclear facilities at these sites.

4) Vegetation beta activity was comparable to activities reported in the Shippingport survey and in a survey made at Knolls Atomic Power Laboratory during a period of normal operation.

5) Soil beta activities were considerably above those reported in the Knolls, Paducah, and Shippingport surveys.

6) The results of this survey probably are not reproducible. The unusually large number of nuclear weapons tests which took place in the period during which this survey was made no doubt had significant effects on the background radiation levels. The exact nature of these effects is not known. Different weather conditions would probably cause the background radiation levels to be different from those reported for this survey.

RECOMMENDATIONS

1) The results of this survey should be compared with those results obtained in the earliest background radiation surveys made at Oak Ridge National Laboratory.

2) The specific nuclides responsible for the short-lived alpha activity in air and the long-lived alpha and beta activity in air, water, soil, and vegetation should be identified.

3) Further background radiation surveys such as this one should be made to determine the effect which different weather conditions have on the radiation levels in the vicinity of ORGDP.

PROCEDURE

Alpha and beta-gamma survey meter readings were taken, and air, water, soil, and vegetation samples were collected in the area extending outward approximately one mile from the fence surrounding the Oak Ridge Gaseous Diffusion Plant (See Figure 1). Both accessibility and the accuracy with which a particular point could be located on a map of the area had to be considered in choosing a point at which to take meter readings and collect samples. Most points were located in the immediate vicinity of landmarks such as sharp turns in a road or fence, bridges, railroad crossings and crossroads. With the exception of several fenced-in areas and some heavily wooded sections, most areas were surveyed.

Air samples were taken with a Type TF 1A, 110 volt AC sampler, manufactured by the Staplex Company, New York. Air was drawn through a No. 41 Genuine Whatman filter paper at rates varying from 20 to 25 cubic feet per minute. Sampling time was about two hours. Power for the sampler was provided by a portable generator. Due to the size of the generator, all air samples had to be taken alongside roads. This was not a major limitation, however, for there were adequate road networks in most of the sections surveyed.

Water samples were collected from the surface and near banks of streams, ponds, and stagnant pools. These samples were free of visible traces of dirt and vegetation.

Surface samples of soil were collected at points where the soil was completely exposed to the air. Soil to a depth of approximately 1/4 inch below the surface was collected.

The following types of vegetation were sampled:

1. Red cedar (Juniperis virginiana) (8)
2. Choke cherry (Prunus virginiana) (9)
3. Poison sumac (Rhus vernix) (10)
4. Loblolly pine (Pinus taeda) (11)
5. Ward's willow (Salix Wardi) (12)
6. Sassafras (Sassafras variifolium) (13)
7. Stinkweed (A very common flowering shrub)
8. Low-growing weeds and grass

Most of the vegetation samples were cedar. With the exception of sumac and low-growing weeds and grass, only one sample of each of the other types of vegetation was collected. At one point, seven different types of vegetation were sampled.

The samples were counted for only one type of radiation at a time. Water samples were analyzed for alpha, beta, and gamma activity; air samples, for alpha and beta activity; and soil and vegetation samples, for beta and gamma activity. In addition, alpha activity was determined for four soil and four vegetation samples.

A brief description of the survey meters and their use and the method of preparation and analysis of the samples are given in Appendices A and B, respectively.

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APPENDIX

A. Survey Meters

1. Description of the Instruments

a. The NICC Model 2610A Beta-Gamma Survey Meter (14) is a complete, portable, battery-operated instrument for the detection and measurement of beta and gamma radiation. Radiation intensities are indicated by a direct reading meter which may be calibrated in terms of milliroentgens per hour. The manufacturer of the instrument is Nuclear Instrument and Chemical Corporation of Chicago, Illinois.

The instrument can be adjusted to read 0.2, 2.0, or 20.0 milliroentgens per hour at full scale. The wall thickness of the probe is 30 milligrams per square centimeter. The beta shield is 2 millimeter brass which is approximately 1.6 grams per square centimeter. The detecting element is a Geiger tube, which is located inside the probe.

For general use, the linearity of the meter is such that adjusting the sensitivity to give a correct reading at or about half scale on the 20 milliroentgen per hour range causes all ranges to be within 10% of their indicated value at any part of the scale.

b. The Samson Alpha Survey Meter (22) is a portable, battery-operated instrument for the detection and measurement of alpha radiation. It will also measure beta and gamma radiation if calibrated for that purpose and can be used to distinguish between the different radiations with the aid of external discriminating shields. The manufacturer of the instrument is Radioactive Products, Inc., of Detroit, Michigan. The meter can be adjusted to read 500, 2,500, or 12,500 counts per minute at full scale.

The detecting component is an ionization chamber which is within the instrument case and which has a sensitive volume of about 40 cubic inches. The minimum detectable alpha radiation is normally about 50-100 counts per minute, which corresponds to approximately 100-200 disintegrations per minute per square centimeter for an alpha emitting material having negligible self absorption.

2. Use of the Survey Meters

All points at which readings were taken with the survey meters are shown in Figure 1. Readings were taken with the face of the detecting element as near as possible to the ground. The beta shield on the beta-gamma survey meter was not used.

B. Preparation and Analysis of the Samples

1. General

In counting each sample a total of 500 counts were recorded, giving a standard deviation of about 5% in each reported counting rate; the corresponding limit of error was about 10%.

All alpha counting rates reported by the laboratory were corrected for self absorption to 50% geometry. All beta counting rates were corrected for self absorption to 100% geometry. An example of how these corrections for self absorption were made is given in the discussion of the counting of soil samples.

2. Air Samples

After the air sampler had run for about two hours in a given location, the filter paper was removed, and, when possible, taken immediately to the laboratory to be counted for short-lived alpha activity. About one day later the filter paper was counted again for long-lived alpha and beta activity.

To determine alpha activity, the filter paper was counted in a parallel plate ionization chamber.

The beta activity was determined using a Model 164 Nuclear Instrument and Chemical Corporation scaler connected to an open-ended Geiger tube.

Air sample activities were reported as counts per minute per cubic foot of air drawn through the filter paper in the air sampler.

3. Water Samples

The gamma counting rate was measured using a Shonka gamma counter setup, consisting of an ion chamber, a vibrating reed electrometer, and an Esterline-Angus chart recorder. On the recorder chart the amount of ionization produced by the sample was compared with that produced by a known amount of natural uranium. No special preparation of the sample was required.

Before alpha and beta counting rates could be determined, the samples had to be evaporated to dryness. The residue was then brought into solution with acid and this solution transferred to a small dish and evaporated to dryness.

To determine the beta activity, a HNO_3 solution of the residue was transferred to a stainless steel dish, evaporated to dryness, and counted with a Model 192 beta proportional counter, manufactured by Nuclear Chicago. The entire beta counting setup consisted of the scaling unit, an automatic sample changer, and a printing timer.

To determine the alpha activity of a water sample, an HCl solution of the residue was placed in a silver dish, evaporated to dryness, and counted in a parallel plate ionization chamber.

Activities of water samples were reported as counts per minute per 100 milliliters of water.

4. Soil Samples

Soil samples were ground so as to pass through a 60 mesh screen and dried for at least 24 hours at 120°C before counting.

The samples were counted for gamma activity with a Shonka counter. No special preparation was required.

For beta counting, 1/2 gram of dried sample was weighed into a small stainless steel dish and a few drops of "Wrap-rax" cement added to hold the sample together. The mixture was then dried on a hot plate and counted for beta activity with a Model 192 beta proportional counter.

The observed beta counting rates were corrected for self absorption in the following manner. A blank sample consisting of a known amount of natural uranium mixed with 1/2 gram of dried soil was counted. The ratio of the counting rate observed for this sample to the counting rate expected for an amount of natural uranium equal to that in the blank sample was determined. This ratio is called the efficiency of the counting setup. The observed counting rate for a soil sample divided by this efficiency gives a counting rate equivalent to the total beta activity of the sample.

To prepare the soil samples for alpha counting, the uranium, along with some thorium and other alpha-emitting materials, was extracted by a rather involved and lengthy analytical technique (20) and then electrodeposited from an ammonium oxalate solution onto a metal plate (21); the samples were then counted in a parallel plate ionization chamber.

Activities of soil samples were reported as counts per minute per 1/2 gram of dried sample.

5. Vegatation Samples

To prepare the vegetation samples for counting, 10 grams of foilage were weighed out into a 100 milliliter platinum dish and dried for two hours at 100°C. The dried material was then cooled and weighed. The dried samples were ashed by adding 5 milliliters of 6N HNO_3. The resulting solution was deposited dropwise into a small stainless steel dish and evaporated to dryness. The dry ash was prepared for alpha counting exactly as were the soil samples. The alpha, beta, and gamma counting techniques were identical to those used for the soil samples.

The presence of vapor in the beta counter affects the counting rate. Therefore, the counting rates for the very hygroscopic vegetation ash are subject to slightly greater uncertainty than the 10% limit of error for completely dry samples.

Vegetation sample activities were reported as counts per minute per gram of dried sample.

C. Climatological Data

Climatological data are given for September, 1958, and for the period during which the background radiation survey was made. Figure 2 is a wind chart for the Oak Ridge Gaseous Diffusion Plant area.

Climatological Data for the Period from October 10 to October 16, 1958

Date	---Temperature--- Max.	Min.	Avg.	Precipitation (inches)	Prevailing Wind Direction	Avg. Wind Velocity (mph)	Avg. Dew Point
10-10-58	74	42	58	0.01	W	5.1	66
10-11-58	67	40	54	0.00	NNW	3.2	25
10-12-58	67	36	53	0.00	NE	5.3	38
10-13-58	74	38	56	0.00	NE	3.8	41
10-14-58	78	43	61	0.00	NE	2.2	50
10-15-58	80	55	68	0.00	NE	3.4	52
10-16-58	80	48	64	0.00	NE	4.4	54

NOTE: Because of the topography of the area in which the plant is located, the prevailing wind direction at the K-25 Building, at which the above readings were taken, is not necessarily the same as that in the area surrounding the plant. The prevailing wind direction is based on a 24 hour observation. The wind direction during the day generally differs from that at night, when northwesterly winds predominate.

D. Survey Data

A complete listing of the survey data is shown in Table III.

U. S. DEPARTMENT OF COMMERCE, WEATHER BUREAU

LOCAL CLIMATOLOGICAL DATA

OAK RIDGE, TENNESSEE AREA STATIONS

SEPTEMBER 1958

X-10

	TEMPERATURE							PRECIP		WIND	
	MAX	MIN	AVG	DP	DD	CD	HI	PREC	SNW	PD	AV
1	85	59	72	45	0	0	13	0		13	34
2	90	55	73	51	0	0	13	0		3	37
3	92	56	74	60	0	0	13	0		2	12
4	91	61	76	64	0	1	12	0		3	20
5	94	62	78	65	0	3	13	0		3	19
6	91	63	77	62	0	2	14	0		10	25
7	85	60	73	65	0	0	14	81		10	25
8	83	52	68	51	0	0	14	0		1	19
9	82	47	65	47	0	0	13	0		3	20
10	85	50	68	59	0	0	13	0		10	16
11	81	65	73	63	0	0	12	0		3	45
12	73	62	68	58	0	0	9	0		2	29
13	82	62	72	59	0	0	8	0		9	14
14	86	55	71	58	0	0	13	0		8	35
15	84	59	72	65	0	0	13	0		9	24
16	89	70	80	66	0	5	12	0		10	54
17	88	64	76	66	0	1	9	13		12	59
18	76	54	65	51	0	0	10	0		2	36
19	78	48	63	47	2	0	15	0		3	29
20	71	60	66	58	0	0	8	30		3	53
21	75	68	72	62	0	0	5	247		9	38
22	83	64	74	59	0	0	9	0		2	30
23	86	62	74	61	0	0	15	0		3	25
24	84	60	72	61	0	0	15	0		8	23
25	83	60	72	63	0	0	15	0		10	15
26	85	62	74	62	0	0	15	0		4	10
27	77	52	65	63	0	0	14	0		3	41
28	71	44	58	42	7	0	14	0		2	23
29	75	47	61	47	4	0	15	0		8	34
30	69	50	60	53	5	0	8	50		10	33
Avg	82.5	57.8									

TEMPERATURE: (°F)

Average monthly		70.2
Departure from normal		-0.9
Highest	94 on	5
Lowest	44 on	28
Number of days with –		
Max. 32° or below		0
Max. 90° or above		5
Min. 32° or below		0
Min. 0° or below		0

HEATING DEGREE DAYS (base 65°):

Total this month	18
Departure from normal	-23
Seasonal total (since July 1)	18
Seasonal departure from normal	-23

COOLING DEGREE DAYS (base 75°):

Total this month	12
Departure from normal	
Seasonal total (since Jan. 1)	243
Seasonal departure from normal	

PRECIPITATION: (In.)

Total for the month	4.21
Departure from normal	+1.24
Greatest in 24 hours 2.73 on	20-21

WIND

Prevailing direction	ENE
Average monthly speed mph	2.9

K-25

	TEMPERATURE							PRECIP		WIND	
	MAX	MIN	AVG	DP	DD	CD	HI	PREC	SNW	PD	AV
1	85	60	73	45	0	0		0		1	40
2	91	56	74	55	0	0		0		3	44
3	90	58	74	57	0	0		0		2	29
4	92	61	77	62	0	2		0		1	20
5	91	62	77	63	0	2		0		2	34
6	91	62	77	60	0	2		0		10	29
7	92	60	76	68	0	1		50		2	20
8	83	53	68	49	0	0		0		2	43
9	82	48	65	47	0	0		0		2	25
10	85	49	67	57	0	0		0		2	30
11	80	64	72	62	0	0		0		2	38
12	75	63	69	60	0	0		0		9	39
13	82	61	72	61	0	0		0		2	24
14	87	56	72	58	0	0		0		2	30
15	86	59	73	67	0	0		0		2	30
16	89	73	81	66	0	6		0		10	65
17	89	65	77	64	0	2		17		2	77
18	77	53	65	55	0	0		0		2	43
19	79	45	62	47	3	0		0		1	32
20	73	61	67	63	0	0		17		2	34
21	77	68	73	64	0	0		228		10	29
22	83	63	73	63	0	0		0		2	26
23	86	61	74	62	0	0		0		2	25
24	84	61	73	61	0	0		0		2	28
25	82	61	72	63	0	0		0		2	24
26	85	63	74	66	0	0		0		2	20
27	80	54	67	66	0	0		0		2	51
28	72	48	60	42	5	0		0		2	35
29	75	46	61	47	4	0		0		8	41
30	73	51	62	54	3	0		58		8	41
Avg	83.2	58.2									

TEMPERATURE: (°F)

Average monthly		70.7
Departure from normal		-0.1
Highest	92 on	4,7
Lowest	45 on	19
Number of days with –		
Max. 32° or below		0
Max. 90° or above		6
Min. 32° or below		0
Min. 0° or below		0

HEATING DEGREE DAYS (base 65°):

Total this month	15
Departure from normal	-23
Seasonal total (since July 1)	15
Seasonal departure from normal	-23

COOLING DEGREE DAYS (base 75°):

Total this month	15
Departure from normal	
Seasonal total (since Jan. 1)	273
Seasonal departure from normal	

PRECIPITATION: (In.)

Total for the month	3.70
Departure from normal	+0.69
Greatest in 24 hours 2.43 on	20-21

WIND

Prevailing direction	NE
Average monthly speed mph	3.5

Y-12

	TEMPERATURE							PRECIP		WIND	
	MAX	MIN	AVG	DP	DD	CD	HI	PREC	SNW	PD	AV
1	85	65	75	46	0	0	13	0		2	33
2	88	59	74	51	0	0	13	0		2	24
3	91	60	76	58	0	1	13	0		14	15
4	90	64	77	62	0	2	12	0		2	22
5	94	63	79	62	0	4	13	0		4	23
6	90	66	78	61	0	3	13	0		12	29
7	87	62	75	66	0	0	13	14		12	22
8	83	55	69	46	0	0	14	0		2	34
9	82	51	67	46	0	0	13	0		4	15
10	85	53	69	53	0	0	10	0		12	24
11	80	67	74	63	0	0	4	0		2	41
12	74	63	68	56	0	0	1	0		3	37
13	82	64	73	56	0	0	6	0		10	21
14	87	56	72	57	0	0	13	0		9	20
15	86	61	74	66	0	0	13	0		9	24
16	91	72	82	67	0	7	5	0		10	69
17	88	66	77	67	0	2	7	18		12	63
18	75	56	66	54	0	0	8	0		2	40
19	78	50	64	52	1	0	11	0		3	19
20	71	60	66	65	0	0	0	27		3	23
21	77	68	73	65	0	0	4	213		12	33
22	84	67	76	63	0	1	8	0		2	26
23	86	63	75	62	0	0	14	0		3	20
24	85	62	74	62	0	0	14	0		10	23
25	83	62	73	65	0	0	15	0		9	16
26	86	64	75	66	0	0	14	0		3	8
27	80	55	68	69	0	0	12	0		2	23
28	72	46	59	42	6	0	13	0		2	33
29	74	49	62	48	3	0	10	0		10	34
30	69	55	62	56	3	0	7	57		11	35
Avg	82.8	60.1									

TEMPERATURE: (°F)

Average monthly		71.5
Departure from normal		+0.5
Highest	94 on	5
Lowest	46 on	28
Number of days with		
Max. 32° or below		0
Max. 90° or above		5
Min. 32° or below		0
Min. 0° or below		0

HEATING DEGREE DAYS (base 65°):

Total this month	13
Departure from normal	-25
Seasonal total (since July 1)	13
Seasonal departure from normal	-25

COOLING DEGREE DAYS (base 75°):

Total this month	20
Departure from normal	
Seasonal total (since Jan. 1)	329
Seasonal departure from normal	

PRECIPITATION: (In.)

Total for the month	3.29
Departure from normal	+0.08
Greatest in 24 hours 2.36 on	20-21

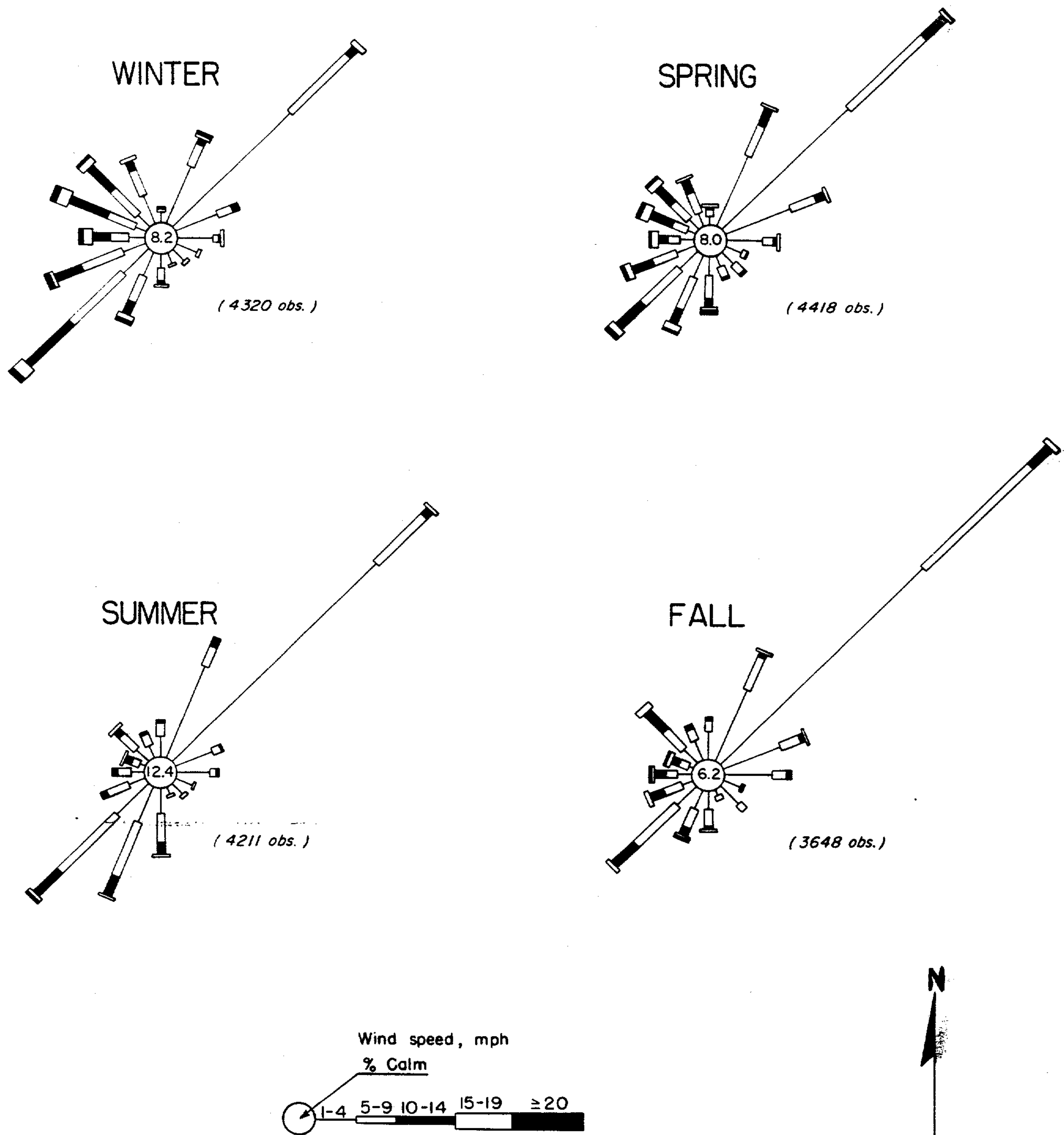
WIND

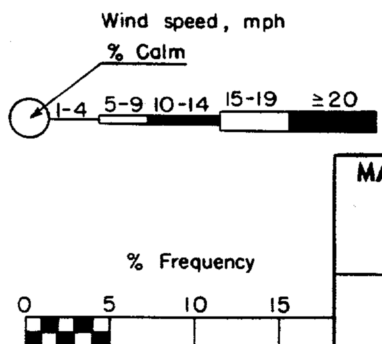
Prevailing direction	NE
Average monthly speed mph	2.8

TEMPERATURE		PRECIPITATION	
MAX	Daily High Mid. to Mid.	PREC	Total, hundredths in.
MIN	Daily Low Mid. to Mid.		
AVG	Daily Mean ½(Max.+Min.)		
DP	Dew Point at Max. Temp.		WIND
DD	Heating Degree Days (65°)		
CD	Cooling Degree Days (75°)	PD	Prevailing Dir. (16pts. NNE-01)
HI	Hours of Inversion	AV	Avg. Wind Speed tenths mph.

USCOMM -WB-Asheville-10/3/1958-200

K-25





MASSACHUSETTS INSTITUTE OF TECHNOLOGY
ENGINEERING PRACTICE SCHOOL
UNION CARBIDE NUCLEAR COMPANY
Division of Union Carbide Corporation

WIND CHART FOR ORGDP AREA

DATE	DRAWN BY	FILE NO.	FIG.
10-22-58		EPS-K-387	2

TABLE III

SURVEY DATA

SURVEY POINT NUMBER[4]	DATE	TYPE OF SAMPLE	DISTANCE FROM CENTER OF "U" (feet)[1]	COUNTING RATE water: counts per minute per milliliter; air: counts per minute per cubic foot; soil and vegetation: counts per minute per gram		SURVEY METER READINGS (Range and Average)	
				alpha	beta	alpha meter, counts per minute	beta-gamma meter, milliroentgens per hour
1	10-10	air[2]	4950	0.0022[2]		50-160[3] Ave. 100	0.02-0.04[3] Ave. 0.03
		red cedar			111		
		loblolly pine			234		
		choke cherry			133		
		poison sumac			180		
		stinkweed			143		
		low-growing weeds			179		
		Ward's willow			191		
		brown dirt			124		
		red clay			112		
		choke cherry bark			136		
2	10-10	red cedar	4100		142	50-200 Ave. 100	0.03-0.05 Ave. 0.045
		sassafras			172		
		red clay			88		
3	10-10	red cedar	4100		192	50-250 Ave. 100	0.035-0.045 Ave. 0.040
		red clay			128		
4	10-10	red cedar	4300		124	0-250 Ave, 100	0.04-0.07 Ave. 0.06
		red clay			132		
5	10-11	air	2850	0.0020		100-200 Ave. 150	0.04-0.06 Ave. 0.05
		red cedar			165		
		red-brown dirt			100		
6	10-11		5950			65-70	0.02-0.04 Ave. 0.03

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TABLE III (Continued)

SURVEY POINT NUMBER	DATE	TYPE OF SAMPLE	DISTANCE FROM CENTER OF "U" (feet)	COUNTING RATE water: counts per minute per milliliter air: counts per minute per cubic foot soil and vegetation: counts per minute per gram		SURVEY METER READINGS (Range and Average)	
				alpha	beta	alpha meter, counts per minute	beta-gamma meter, milliroentgens per hour
7	10-11	air	1650	0.00195		0-200	0.02-0.05
		low-growing weeds			119	Ave. 50	Ave. 0.04
		brown dirt			652		
8	10-11	red cedar	1700		270		
		water		0.96	1.67		
9	10-11	low-growing weeds	3550		140	30-160	0.03-0.05
		brown dirt			198	Ave. 70	Ave. 0.035
10	10-11	red cedar	3400		170		0.02-0.04
		brown dirt			122		Ave. 0.03
	10-16	poison sumac			145	10-80	
						Ave. 30	
11	10-11	low-growing weeds	2500		210		0.025-0.05
		tan soil			144		Ave. 0.04
	10-16					30-130	0.035-0.055
						Ave. 70	Ave. 0.045
12	10-11	red cedar	2850		98		
13	10-11	red cedar	2900	30	95		0.02-0.03
		tan dirt		20	132		Ave. 0.025
	10-16	poison sumac			252	10-100	
						Ave. 40	
14	10-11	red cedar	3600		151		0.03-0.05
		clay			106		Ave. 0.04
	10-16					20-100	
						Ave. 40	
15	10-11	red cedar	4500		224		0.03-0.04
		red-brown soil			80		Ave. 0.035
	10-12	air		0.00357	0.0307		
	10-16	poison sumac			264	0-70	
						Ave. 25	

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TABLE III (Continued)

SURVEY POINT NUMBER	DATE	TYPE OF SAMPLE	DISTANCE FROM CENTER OF "U" (feet)	COUNTING RATE water: counts per minute per milliliter air: counts per minute per cubic foot soil and vegetation: counts per minute per gram		SURVEY METER READINGS (Range and Ave.	
				alpha	beta	alpha meter, counts per minute	beta-gamma meter, milliroentgens per hour
16	10-12	red cedar red clay	4350		153 110		0.025-0.045 Ave. 0.035
	10-16					10-80 Ave. 30	
17	10-12	gray rock	2750		174		0.025-0.035 Ave. 0.030
	10-16					10-80 Ave. 30	
18	10-12	red cedar tan dirt	8500		144 148		0.025-0.040 Ave. 0.030
	10-16					30-50 Ave. 40	0.03-0.04 Ave. 0.035
19	10-12		7750				0.01-0.05 Ave. 0.02
	10-16					0-100 Ave. 30	0.025-0.04 Ave. 0.03
20	10-12	air red cedar brown dirt	5650	0.0020	0.0477 162 174		0.02-0.05 Ave. 0.035
	10-16					10-120 Ave. 50	0.04-0.055 Ave. 0.045
21	10-12	red cedar tan dirt	7850		143 104		0.015-0.040 Ave. 0.025
22	10-12	red cedar tan dirt	6900		153 82		0.02-0.055 Ave. 0.035
	10-16					20-120 Ave. 50	0.03-0.05 Ave. 0.04

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TABLE III (Continued)

SURVEY POINT NUMBER	DATE	TYPE OF SAMPLE	DISTANCE FROM CENTER OF "U" (feet)	COUNTING RATE water: counts per minute per milliliter air: counts per minute per cubic foot soil and vegetation: counts per minute per gram		SURVEY METER READINGS (Range and Average	
				alpha	beta	alpha meter, counts per minute	beta-gamma meter, milliroentgens per hour
23	10-12	brown dirt	7350		146		0.02-0.035 Ave. 0.025
	10-16					0-50 Ave. 20	0.035-0.05 Ave. 0.04
24	10-12	air	6000	0.0039	0.157		0.035-0.065 Ave. 0.05
		red cedar		12	95		
		tan dirt		10	190		
	10-16					30-110 Ave. 60	0.04-0.065 Ave. 0.055
25	10-12	red cedar	6600		154		0.025-0.05 Ave. 0.040
		red clay			154		
	10-16	air(2)		0.0238 (22 hr.) 2.47 (43 min.)		20-60 Ave. 30	0.03-0.04 Ave. 0.035
		poison sumac			269		
26	10-12	brown dirt	5900		198		0.01-0.05 Ave. 0.03
	10-13	air		0.0032	0.0949		
	10-16					20-100 Ave. 50	0.04-0.055 Ave. 0.050
27	10-12	red cedar	6850		119		0.03-0.06 Ave. 0.05
		red-brown clay			170		
	10-16					0-90 Ave. 30	0.03-0.05 Ave. 0.035
28	10-12	red-brown dirt	5350		126		0.035-0.050 Ave. 0.045
	10-16					10-60 Ave. 30	0.04-0.065 Ave. 0.050

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TABLE III (Continued)

SURVEY POINT NUMBER	DATE	TYPE OF SAMPLE	DISTANCE FROM CENTER OF "U" (feet)	COUNTING RATE water: counts per minute per milliliter air: counts per minute per cubic foot soil and vegetation: counts per minute per gram		SURVEY METER READINGS (Range and Ave.)	
				alpha	beta	alpha meter, counts per minute	beta-gamma meter, milliroentgens per hour
29	10-12	red cedar	5300		157		0.03-0.05 Ave. 0.035
		red-brown dirt			126		
	10-16					10-120 Ave. 50	0.025-0.04 Ave. 0.035
30	10-12	brown dirt	4400		186		0.03-0.04 Ave. 0.035
	10-16					0-100 Ave. 40	0.025-0.045 Ave. 0.035
31	10-12	red cedar	4650		132		0.03-0.05 Ave. 0.04
		dark brown dirt			202		
	10-16					0-100 Ave. 30	0.03-0.055 Ave. 0.040
32	10-13	red cedar	4850		65	100-300 Ave. 150	0.02-0.08 Ave. 0.05
		brown dirt			214		
33	10-13	red cedar	4450		112	100-150 Ave. 130	0.03-0.06 Ave. 0.045
		tan dirt			100		
34	10-13	red cedar	2900		183	80-140 Ave. 100	
		gray-brown soil			60		
35	10-14	air	4400	0.0284 (21 hr.) 1.74 (3 hr.)	0.138	20-90 Ave. 40	0.03-0.05 Ave. 0.04
		red cedar			163		
		gray dirt			480		
		water		0.060	0.170		

TABLE III (Continued)

SURVEY POINT NUMBER	DATE	TYPE OF SAMPLE	DISTANCE FROM CENTER OF "U" (feet)	COUNTING RATE water: counts per minute per milliliter air: counts per minute per cubic foot soil and vegetation: counts per minute per gram		SURVEY METER READINGS (Range and Average)	
				alpha	beta	alpha meter, counts per minute	beta-gamma meter, milliroentgens per hour
36	10-14	air	4700	0.00970(21 hr.) 0.747(90 min.)	0.103	less than 30	0.03-0.05 Ave. 0.04
		loblolly pine			275		
		red-brown soil			270		
37	10-14	air	4050	0.0066	0.101	0-60 Ave. 30	0.03-0.05 Ave. 0.04
		red cedar			100		
		gray dirt			146		
38	10-14	red cedar	4750		112	10-70 Ave. 25	0.02-0.04 Ave. 0.03
		sandy soil			34		
39	10-14	red cedar	4050	16	181	10-50 Ave. 30	0.03-0.05 Ave. 0.04
		red clay		12	92		
40	10-14	red cedar	3900		166	30-80 Ave. 40	0.03-0.05 Ave. 0.04
		red-brown clay			128		
41	10-14	red-brown clay	4250		360	50-120 Ave. 75	0.04-0.06 Ave. 0.05
		water		0.26	0.18		
	10-16	air		0.0133 (19 hr.) 0.590 (45 min.)			
42	10-15	air	7400	0.0167 (22 hr.) 0.785 (1 hr.)	0.107	40-160 Ave. 80	0.03-0.05 Ave. 0.035
		brown dirt			278		
43	10-15	red cedar	4900		243	0-50 Ave. 10	0.02-0.03 Ave. 0.025
		brown dirt			178		
		water		0.12	0.15		

TABLE III (Continued)

SURVEY POINT NUMBER	DATE	TYPE OF SAMPLE	DISTANCE FROM CENTER OF "U" (feet)	COUNTING RATE water: counts per minute per milliliter air: counts per minute per cubic foot soil and vegetation: counts per minute per gram		SURVEY METER READINGS (Range and Ave.)	
						alpha meter, counts per minute	beta-gamma meter milliroentgens per hour
				alpha	beta		
44	10-15	red cedar red clay	5200	16 18	106 122	20-130 Ave. 80	0.05-0.08 Ave. 0.06
45	10-15		4000			20-120 Ave. 50	0.04-0.05 Ave. 0.045
46	10-15	air	4150	0.00917 (19 hr.) 0.883 (50 min.)	0.111		
47	10-15	red cedar red-brown clay	6200		237 110	10-50 Ave. 20	0.05-0.07 Ave. 0.06
48	10-15	red cedar red clay	7450		181 28	50-120 Ave. 80	0.04-0.06 Ave. 0.05
49	10-15		7800			70-130 Ave. 100	0.03-0.04 Ave. 0.035
50	10-15		7150			70-210 Ave. 140	0.04-0.06 Ave. 0.045
51	10-15	brown dirt water	3600	 0.040	64 0.20	30-100 Ave. 50	0.06-0.08 Ave. 0.07
52	10-15	red cedar brown dirt	6400		178 62	0-120 Ave. 50	0.03-0.04 Ave. 0.035
53	10-15		5500			0-70 Ave. 25	0.04-0.05 Ave. 0.045

NOTES:

(1) The center of the "U", as referred to in this report, is located at the center of the K-1024 Building. The K-1024 Building is in the center of the area enclosed by the circle on the map of Figure 1.

(2) Where two alpha counting rates are given for a single air sample, one is due mainly to short-lived and, the other, to long-lived alpha emitters. Beside each counting rate is the time elapsed between the stopping of the air sampler and the counting of the filter paper.

(3) In many instances, alpha and beta-gamma survey meter readings were not taken on the same day at a given point, nor on the same day that samples were collected. This was due to operational difficulties with the survey meters.

(4) All survey points are shown in Figure 1.

E. Location of Original Data

The original data are recorded on pages 75-98 in Unclassified Data Book No. 4, on file at the M.I.T. Engineering Practice School, K-1008-C, Union Carbide Nuclear Company, ORGDP, Oak Ridge, Tennessee.

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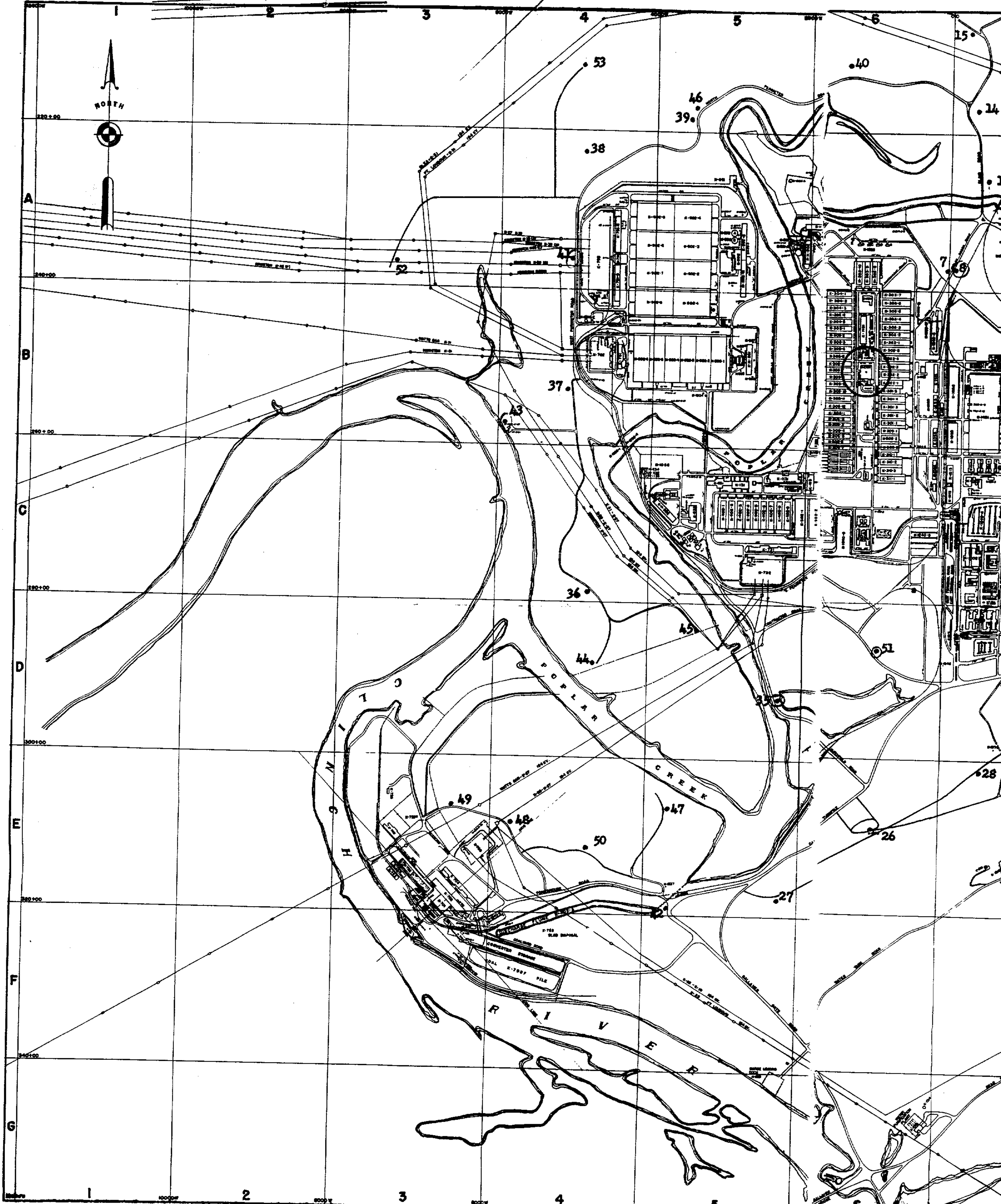
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POPLAR CREEK
CLINCH RIVER
SLAG DISPOSAL
CONVERTER STORAGE
COAL PILE

KT-369

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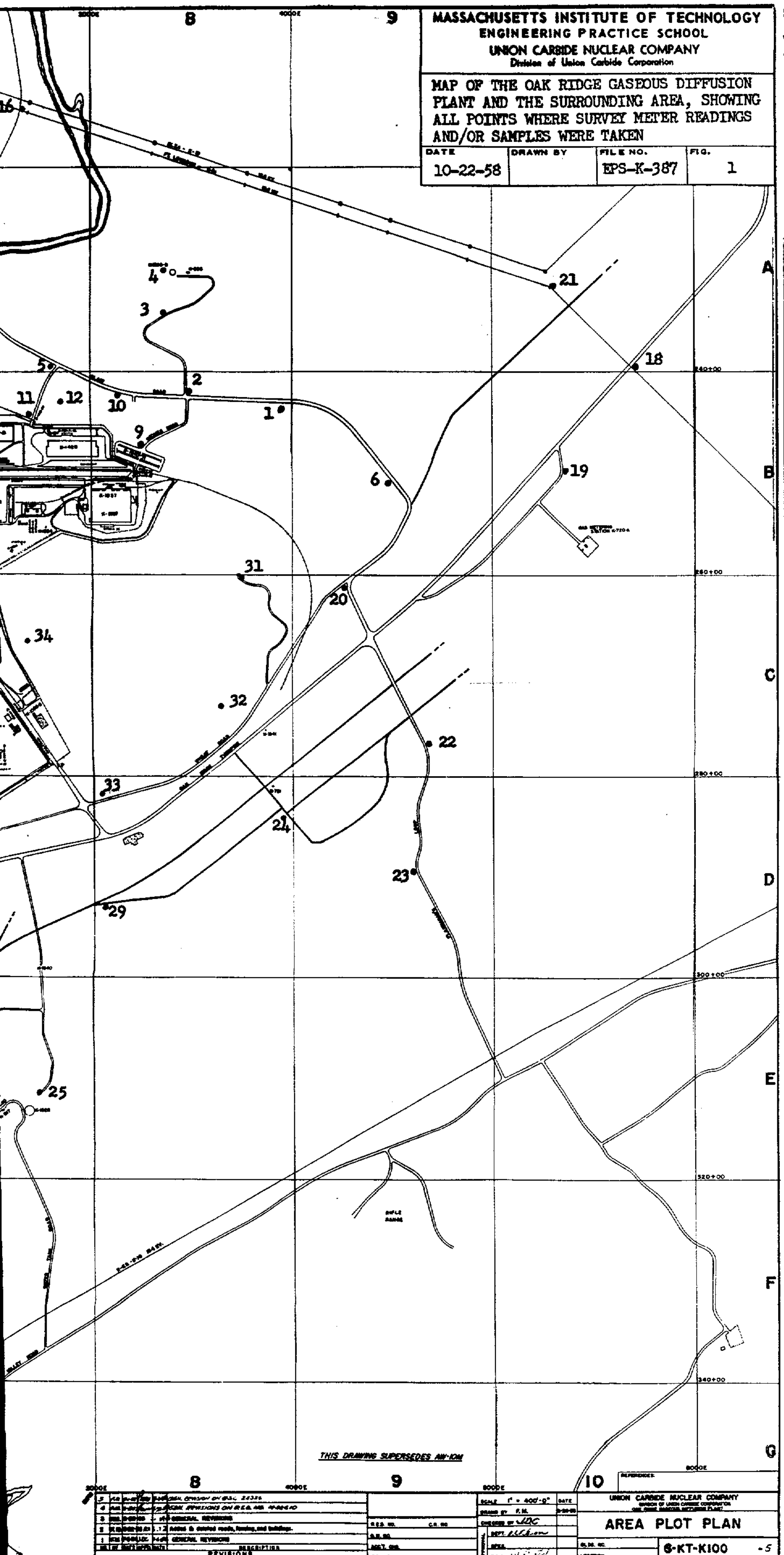
UNION CARBIDE NUCLEAR COMPANY
Division of Union Carbide Corporation

MAP OF THE OAK RIDGE GASEOUS DIFFUSION PLANT AND THE SURROUNDING AREA, SHOWING ALL POINTS WHERE SURVEY METER READINGS AND/OR SAMPLES WERE TAKEN

DATE	DRAWN BY	FILE NO.	FIG.
10-22-58		EPS-K-387	1



UNION CARBIDE NUCLEAR COMPANY

AREA PLOT PLAN

SCALE 1" = 400'-0"

REVISIONS

6-KT-K100 -5

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